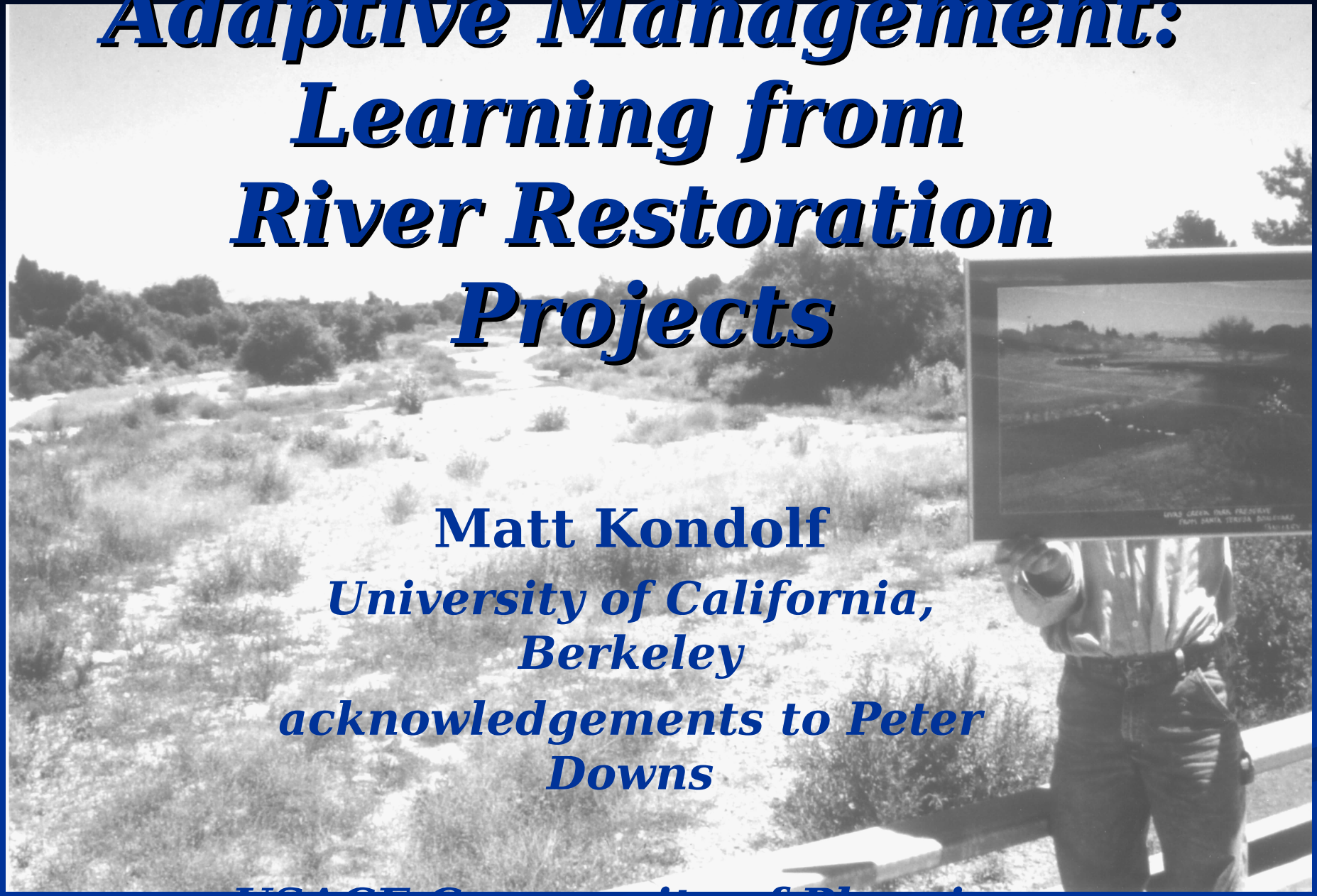
Adaptive Management: Learning from River Restoration Projects



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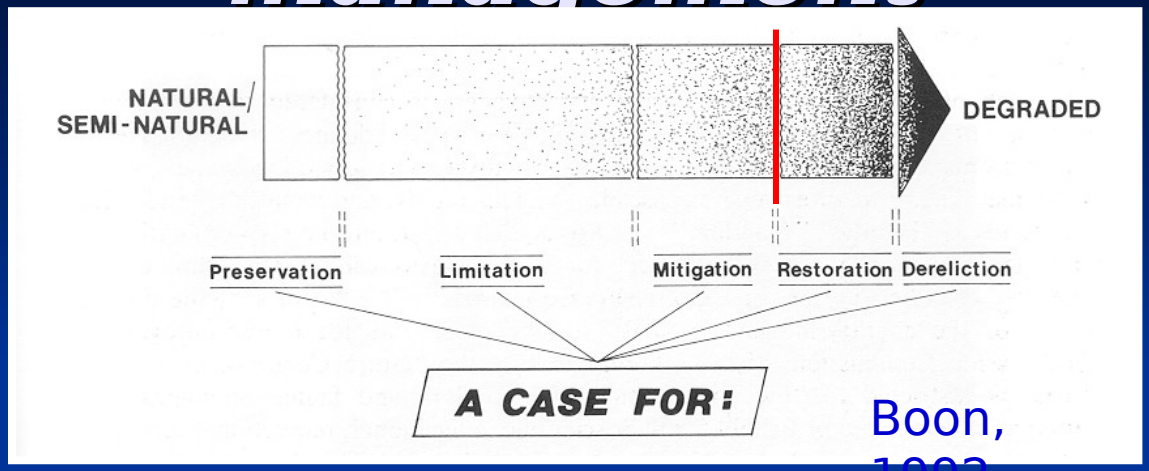
acknowledgements to Peter Downs

...restoration & adaptive management



Boon, 1992

Adaptive Management: actively learning through experience,
in systems characterised by uncertainty

River restoration: the return of an ecosystem
to a close approximation of its condition prior to disturbance

...is this uncertain?

US Army Corps and Restoration

- role in ecosystem restoration increasing

- expertise: research, implementation experience, geographic coverage

- shift from building new projects to reoperating and restoration

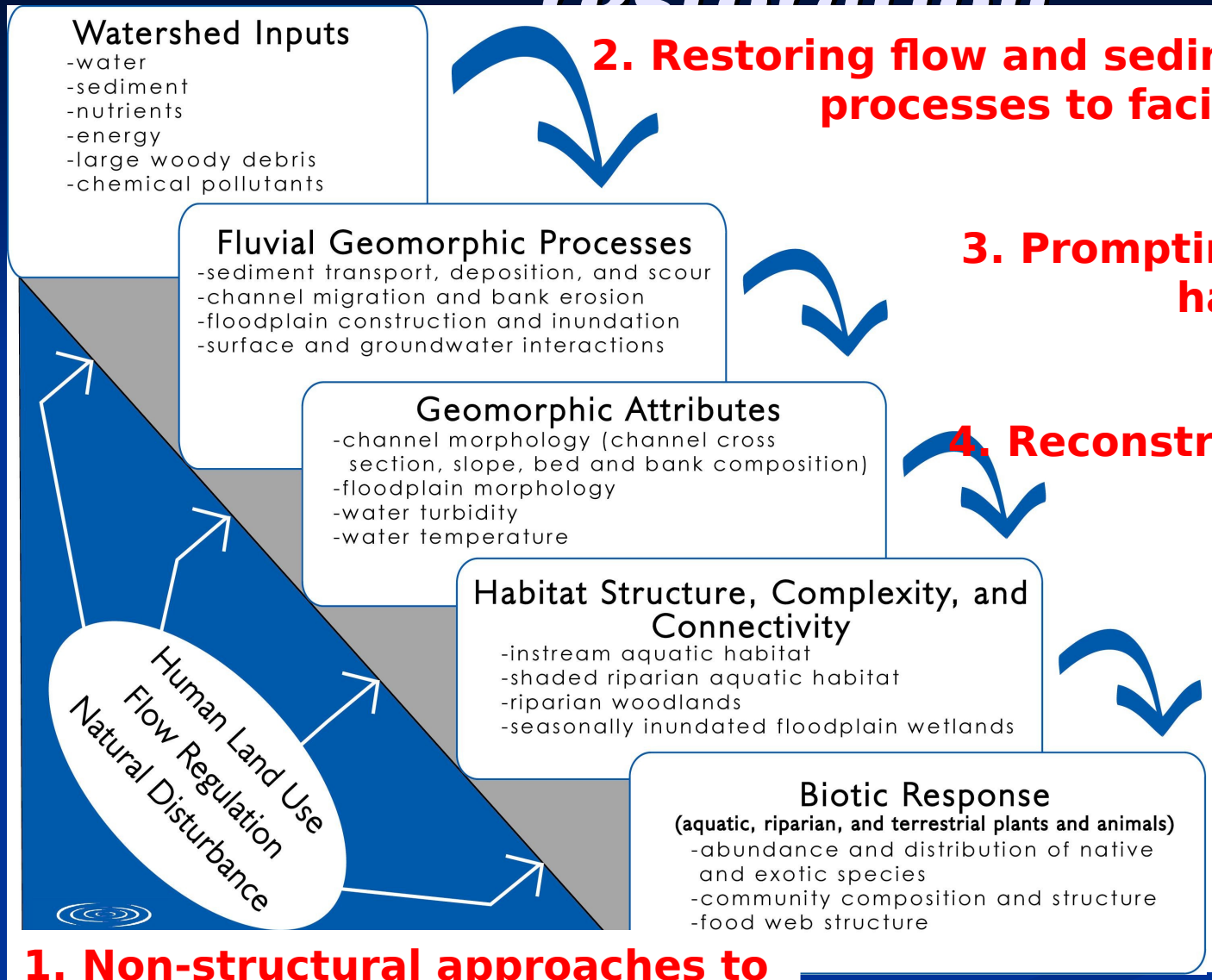
But

- institutional barriers to adaptive management

- difficult to reward (unlike normal PM reward structure)

EAB concept: Ecosystem Restoration

Origins of uncertainty in restoration



2. Restoring flow and sediment transport processes to facilitate recovery

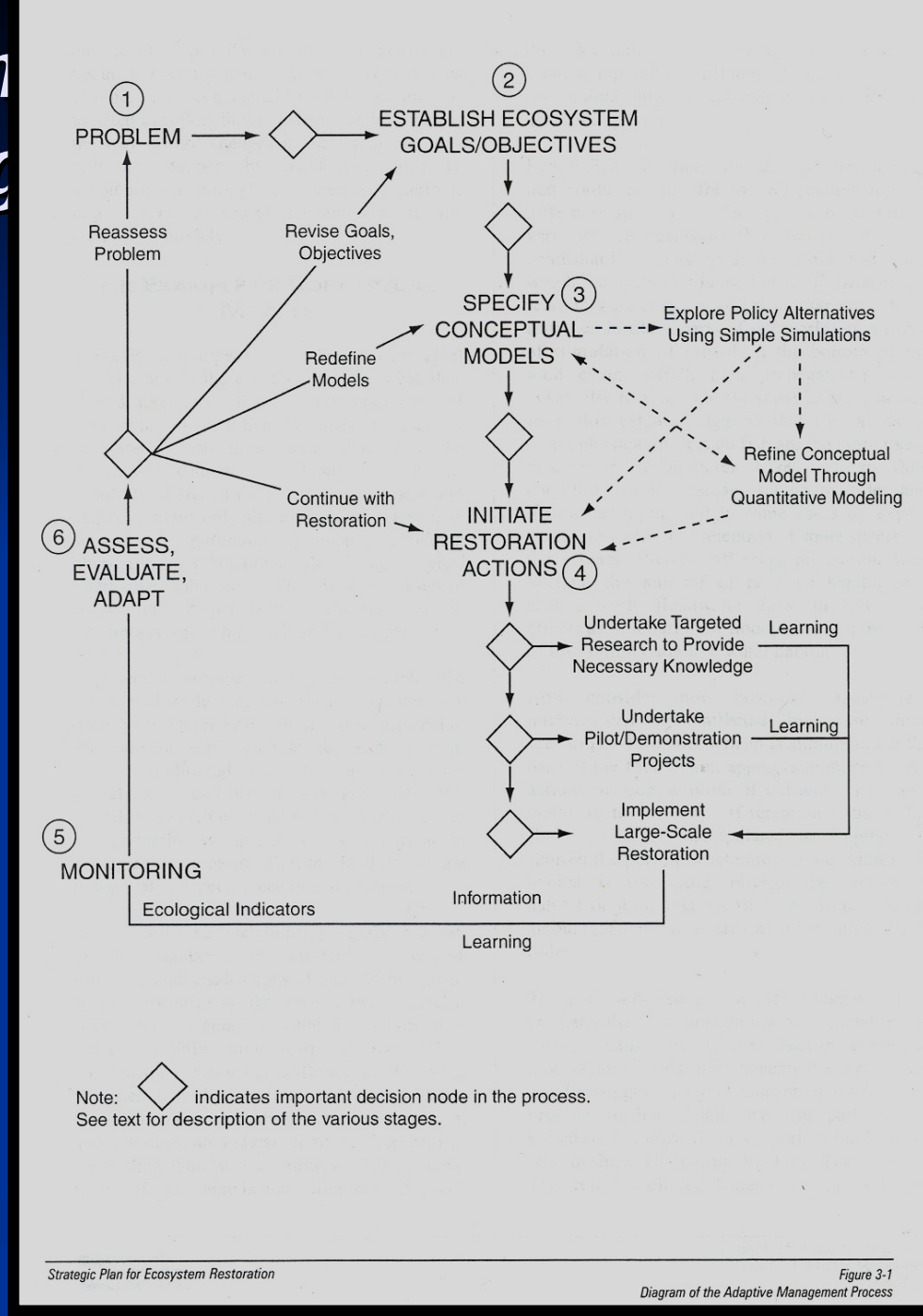
3. Prompting recovery for habitat diversity

4. Reconstructing channel morphology

1. Non-structural approaches to preservation & natural recovery

Adaptive managem "learning by doing

- Breaks with prior experience as the primary basis for management
- Allows management in the face of uncertainty…
- not trial & error: needs hypotheses, mathematical models for uncertainties, statistical models for error propagation, formal optimisation procedures
- ecosystem monitoring is integral



Active vs. passive AM

- **Passive Adaptive Management**
  - Think of plausible solution to management problem
  - Subject potential solutions to structured analysis to determine most promising option
  - Specify indicators of success for most promising option
  - Implement and monitor
  - Adjust the design periodically according to monitoring results
- **Active Adaptive Management**
  - Think of plausible solution to management problem
  - Subject potential solutions to structured analysis to determine how uncertainty in system response affects potential success or failure
  - Where uncertainty exists, design a scheme to test between two or more alternatives
  - Use monitoring results to re-evaluate the alternatives

Post-Project Appraisals

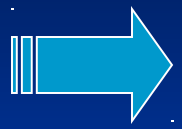
"evaluations of the effectiveness of projects based on systematic data collection and assessment tested against measurable success criteria"

To determine:

1. whether a project was implemented as designed
2. evaluate the degree of reaching objectives
3. whether unanticipated effects need addressing
4. to improve future designs

PPA & river restoration

River engineering appraisals construction-centred short-term



River management appraisals effect-centred long-term

River restoration success under AM:

- achievement of *ecosystem performance goals*
- achievement of a *significant learning experience*

Focus of physical elements of PPA:

- Understanding ***compliance***
- Indication of short-term geo-hydraulic ***performance***
- Geomorphological evaluation of longer-term ***sustainability***

PPA: critical information

- availability of pre-project data
- period of post-project monitoring
- (inverse) dependency on secondary analysis
- transferable information needs understanding of geomorphological-hydrological interactions

Five classes:

- Full, Medium-term, Short-term, One-shot, Remains

More: Downs, P.W. and Kondolf, G.M. 2002 *Environmental Management*
"Post-project appraisals in adaptive management of river channel restoration"

Categories of PPA: information

	Category of post-project appraisal				
	Full	**Medium-term**	**Short-term**	**One-shot**	**Remains**
Pre-project	*Level of commitment*				
Success criteria					
Baseline surveys					
Design rationale					
Design drawings					
As-built drawings					
Post-project	*Level of commitment*				
Monitoring surveys	>10 years	5-10 years	<5 years		
Historical analysis					
Secondary analyses					

The ability to learn…

	Category of post-project appraisal				
	Full	**Medium-term**	**Short-term**	**One-shot**	**Remains**
Understanding **compliance**	**yes**	**yes**	**yes**	**possible**	**speculation**
Indication of short-term geo-hydraulic **performance**	**yes**	**probable**	**possible**	**possible**	**speculation or none**
Indication of longer-term **sustainability**	**probable**	**possible**	**speculation**	**speculation**	**speculation or none**

Effective evaluations & maximizing learning…

1. Context:
   a. Time and river channel sensitivity to change
   b. Space and differentiating performance
2. Specifying environmental targets: implications of AM “experiments”
3. What do we learn?
4. PPAs for reducing uncertainty in river restoration…what it means in practice

Restoration as experiments

- Limit effectiveness evaluation to monitoring metrics that are expected to change reliably within experimental constraints
- "Proof":
  - Population status and trends: you may need an order of magnitude more time to prove biological rather than physical trends
  - Weight-of-evidence: framework for rigorously testing hypotheses to identify, address and reduce uncertainties in the fundamental issues surrounding the effects of restoration on geomorphology, habitat and population responses of in-stream and floodplain flora and fauna

Flow pulse restoration targets

Operational changes

Flow: met predicted magnitude, duration, frequency
and timing of intentional flow releases?

Geomorphic processes: met predicted rec
transport frequency and distance for gravel?

Channel morphology: met predicted stream structure target
E.g., riffle quality, pool depth, floodplain depositional topogr

Habitats: met predicted spawning habitat quality,
extent of low velocity marginal habitat?

Biota: met predicted benthic macroinvertebrate bioma
and diversity, increasing holding in pools,
recruitment of cottonwood seedlings?

Implications for restoration engineering

- PPAs can reduce restoration uncertainties but imply altering the management process
- Under adaptive management, river restoration becomes an explicit part of achieving new experiences and knowledge and 'learning by surprise' (McLain & Lee, 1996) using 'sound science and reasoned thought' (Wieringa & Morton, 1996) rather than learning by 'trial and error'
- Conservative design solutions can be considered wasteful practice
- Effectively targeted PPAs can inform cutting-edge approaches to river restoration that are 'complex': a strategy of bravery lying on the boundary between order (cowardice) and chaos (recklessness) (Geldof, 1995)

Management process implications

- Managers need to broaden their restoration expectations to include the generation of new information, implying:
- Design and implement monitoring programs before planning restoration / management actions
- Recognize the need for hierarchical monitoring programs and learn how to implement them
- Eliminate myths about monitoring, including assumptions that we can generate reliable new data just from observations; need a scientifically rigorous framework

Ralph and Poole 2002

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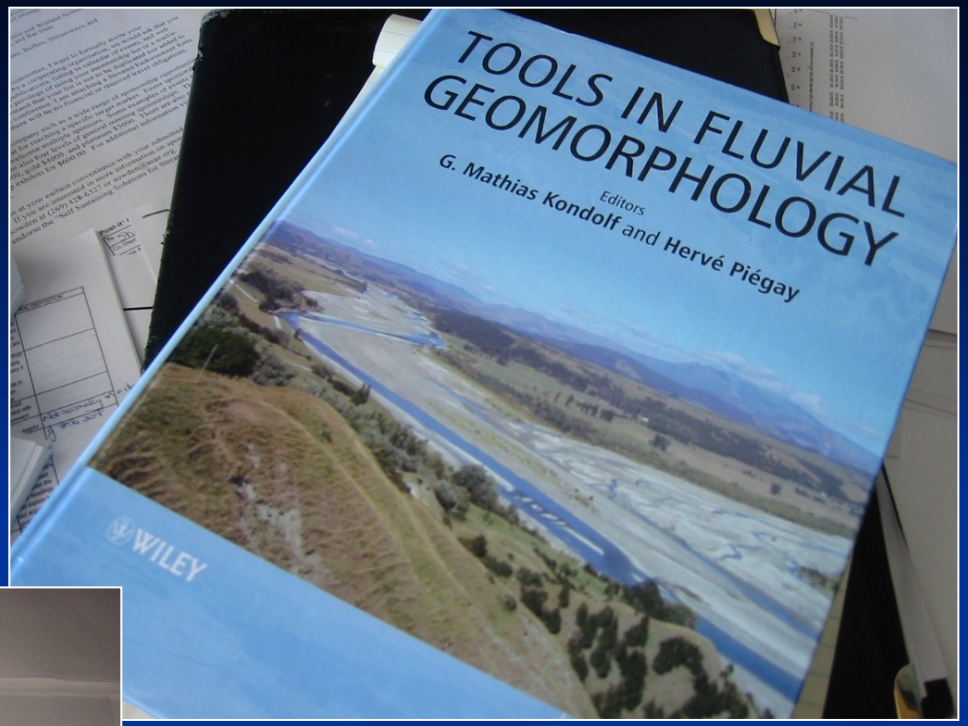
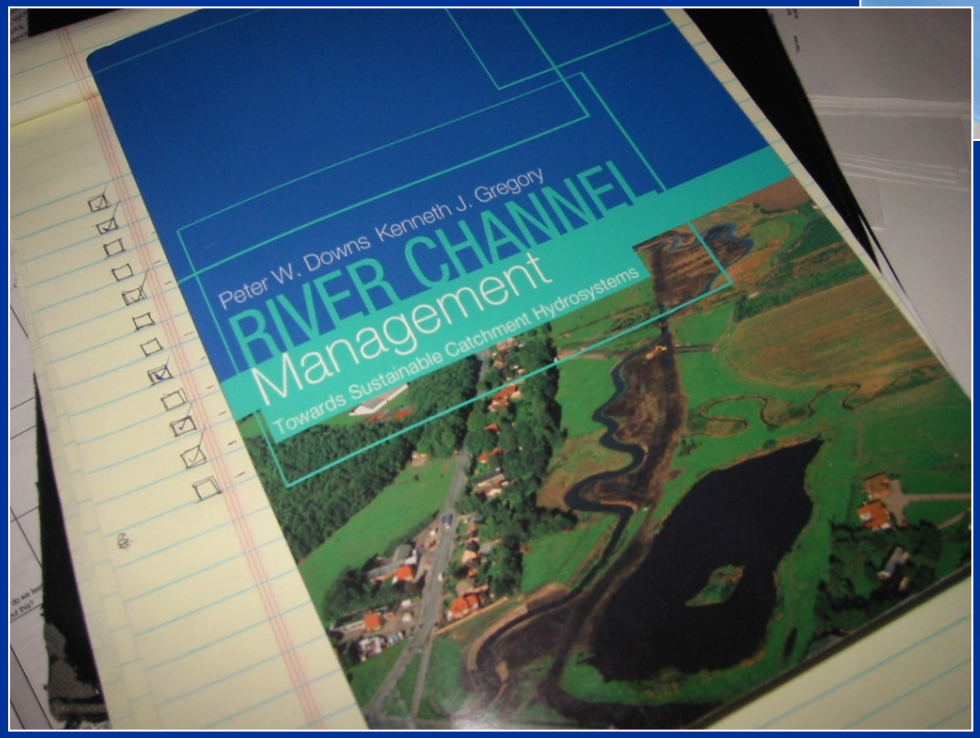
2003, Wiley





Downs, P.W. and Gregory, K.J.
River Channel Management: towards sustainable catchment hydrosystems
June 2004, Arnold